Small Business Innovation Research/Small Business Tech Transfer

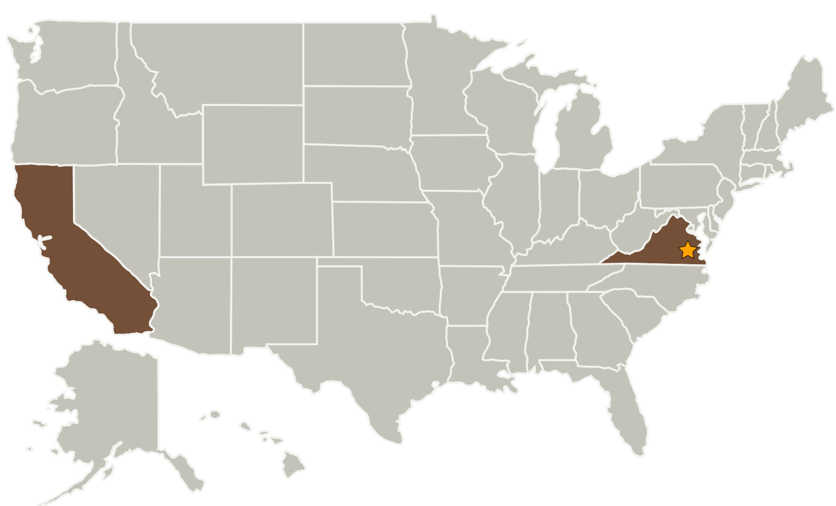
Computational Aeroacoustics Using the Generalized Lattice Boltzmann Equation, Phase II

Completed Technology Project (2006 - 2008)

Project Introduction

The research proposed targets airframe noise (AFN) prediction and reduction. AFN originates from complex interactions of turbulent flow with airframe components that are extremely difficult to compute efficiently and accurately. In Phase I the feasibility of an innovative generalized lattice Boltzmann equation (GLBE) approach as a computational aeroacoustics (CAA) tool was evaluated. A subgrid scale (SGS) with wall damping was introduced into the GLBE to enable large eddy simulations. GLBE results on wall turbulence statistics compared well with direct numerical simulations and experiments. The GLBE approach, which uses multiple relaxation times, was significantly more stable than, and as computationally efficient as, the more common single-relaxation time LBE at high Reynolds numbers. It was also computationally competitive with finite-difference methods on single processors, but GLBE had the major advantage of scaling near-linearly on large parallel computers. GLBE computations also accurately reproduced the tonal frequencies for cross-flow over a single, and a pair of cylinders, and feedback-generated tonal frequencies for flow over cavities, which are CAA benchmarks for AFN. With feasibility demonstrated in Phase I, further developments of GLBE, including innovative use of wall-layer models, dynamic SGS models, improved boundary condition implementation and grid refinement strategies in Phase II would enable simulations of very high Reynolds number CAA problems of complex geometry with high fidelity. The GLBE approach developed will then be interfaced to an existing far-field acoustics prediction code to efficiently address AFN in configurations of interest, including high-lift systems and landing gear.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Langley Research Center (LaRC)

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Organizations Performing Work	Role	Type	Location
★Langley Research Center(LaRC)	Lead Organization	NASA Center	Hampton, Virginia
MetaHeuristics	Supporting Organization	Industry	Santa Barbara, California

Primary U.S. Work Locations	
California	Virginia

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  └ TX15.1 Aerosciences
    └ TX15.1.4 Aeroacoustics